NAVAL MEDICAL RESEARCH UNIT
DAYTON, OHIO

Science Update

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NAMRU-D MISSION:

To maximize warfighter performance and survivability through premier aeromedical and environmental health research-delivering solutions to the field, the Fleet, and for the future.

Inside this issue:

NAMRU-D Headquarters and Aeromedical Research Directorate Building (WPAFB Bldg 851)

BRAC MILCON Complete

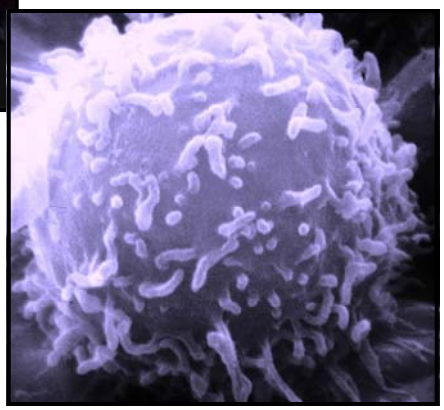
By Larry Schoenberg

1 March 2011 marked the much anticipated Building Occupancy Date (BOD) for the state-of-the-art facility housing Naval Medical Research Unit-Dayton (NAMRU-D) headquarters and the newly established Aeromedical Research Directorate. This monumental milestone represents the completion of the Base Realignment and Closure (BRAC) Military Construction (MILCON) project, resulting in a cutting edge DoD Aeromedical Joint Center of Excellence at Wright Patterson Air Force Base. The next phase for NAMRU-D will be to transition aeromedical personnel and research equipment transferring from the Naval Aerospace Medical Research Laboratory (NAMRL) at NAS Pensacola. Significant progress has been made toward achieving a fully operational facility, with a target completion date of 15 September 2011, coinciding with the end of the congressionally mandated BRAC. The Commanding and Executive Officers now occupy the Command Suite and are directing operations from their new location. Key engineering support personnel have moved into the facility, and a fully operational fabrication shop is installed and prepared to provide research support to scientists with a wide array of high tech fabrication equipment. The Vision Lab, complete with a fully outfitted eye lane, is ready to support critical vision science research. The Vertical Linear Accelerator, installed and fully operational, is awaiting final acceptance for human use certification. The Visual Vestibular Sphere Device was delivered and structural components have been reassembled. The device is expected to be fully wired and operational within the next three weeks. The Disorientation Research Device's (DRD) main electrical drives are in place, and this past week the device's planetary tower assembly, which houses the main drive motors, was placed. The planetary tower is the heart of the DRD and represents the first major device assembly to arrive at NAMRU-D. The first phase of the equipment move from Pensacola is complete and reassembly of the Hypoxia and Psychophysiology Labs is underway. NAMRL and NAMRU-D are well on the way to completing the BRAC mandated move to Dayton and achieving the goal of a seamless transition with minimal impact on critical research capabilities.

(Photos on pages 3 & 6)

Collaborative Research Brings Better Understanding of Tungstate Exposure Risks

Left: Munitions can contain tungsten carbide cores
Below: Electron microscopic image of a single human lymphocyte



By Dr. Andrew R. Osterburg

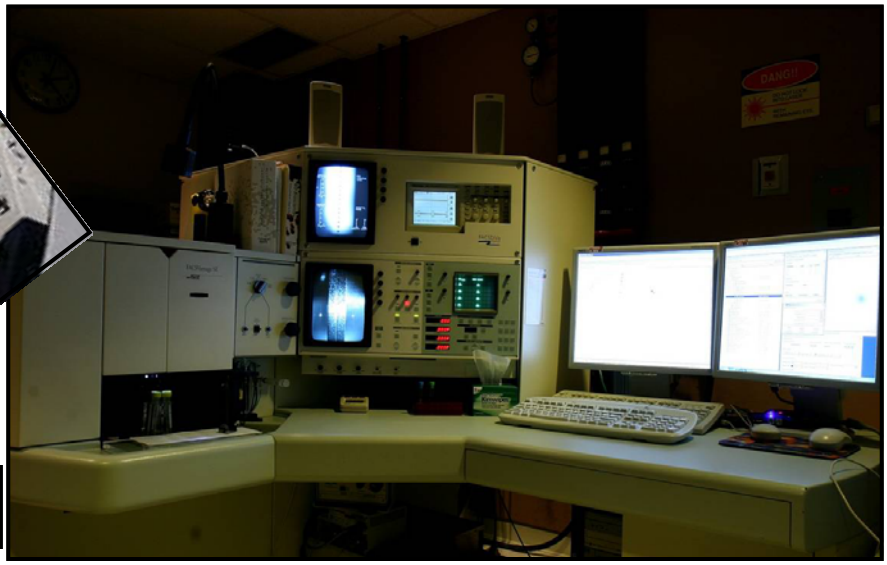
Researchers at NAMRU-Dayton and the University of Cincinnati/ Shriners Hospital for Children (UCSH) recently teamed to investigate the effects of tungstate exposure on immune system function. When tungsten alloys first began to replace lead and depleted uranium in munitions, they were believed to be inert. However, studies revealed that tungsten and tungstate, the water soluble form of the metal, might have detrimental effects on the health of those exposed. These studies revealed that tungstate inhibits a key cellular protein involved in immune system function, xanthine oxidase. Although previous research had begun to clarify such cellular responses, data on the effects of different exposure levels were sparse.

With funding from the Office of Naval Research (ONR), and in collaboration with Dr. George Babcock's laboratory at UCSH, NAMRU-Dayton scientists launched an investigation into the potential immunotoxic effects of tungstate exposure. Because tungstate is largely a ground water contaminant, the main route of exposure is oral. Therefore, NAMRU-D and UCSH investigators exposed mice to various concentrations of tungstate in drinking water continuously for 28 or 90-days. After the exposures, immune responses of the mice were measured. The data indicated that tungstate suppressed the immune system, but only at the high concentrations, to which humans are not likely exposed. The research team discovered that the types of cells tungstate suppressed are the so-called helper and cytotoxic T-cells. These cells are central to adaptive immunity and help to coordinate the immune response to pathogens and eliminate damaged and/or foreign cells. Perhaps more importantly, the data also suggested that the quantity of tungstate an individual might be exposed to from ground water contamination is significantly lower than the dose that resulted in immunosuppression.

This study showcased how Navy and University laboratories can bring unique but complementary capabilities to a scientific collaboration, executing research that either would have difficulty doing alone. The result of this scientific collaboration was an enhanced understanding of the effects of tungstate exposure, providing the DoD with a critical building block for exposure risk assessments.

Below: Military service members loading munitions

Right: Cell sorting device



NAMRU-D Presents at the Armed Forces Public Health Conference

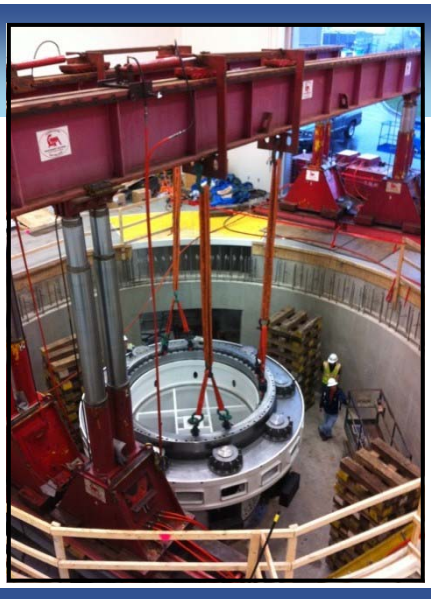
NAMRU-Dayton researchers presenting at AFPHC (Left to right): Dr. Karen Mumy; Dr. Mike Gargas; CDR Dan Hardt; LT Pedro Ortiz; Dr. Brian Wong; Dr. Andrew Osterburg

By CDR Daniel Hardt

The first annual Armed Forces Public Health Conference (AFPHC) was held in Hampton, VA on 21-25 March 2011, with the timely theme: **"Public Health in a Joint Environment"**. Five NAMRU-Dayton research scientists provided platform presentations at the inaugural event, which now serves as a key educational forum to address joint and multinational common public health challenges, approaches, methods, policies, principles, procedures, and technologies. LT Pedro Ortiz presented data that correlated jet fuel inhalation exposures with an increased rate of noise-induced hearing loss in rats. Dr. Karen Mumy showed recent data to support using improved *in vitro* techniques to rapidly evaluate the toxicity of traditional and alternative military fuels, and mixtures. CDR Daniel Hardt provided an update of the latest research to assess the health risks to service members exposed to "burn pit" emissions, including the development of a small-scale burn pit model operating under controlled ambient conditions at the Battelle West Jefferson facility near Columbus, OH. Dr. Andrew Osterburg presented data to suggest that tungsten, after being oxidized to a tungstate anion, may have the capability to alter the responsiveness of the immune system. Finally, Dr. Brian Wong provided an update on the latest strategies and technologies for evaluating the toxicity of nanomaterials via inhalation exposures, and outlined an exposure system for future nanomaterial research at NAMRU-Dayton laboratories. These presentations were well received and demonstrate NAMRU-Dayton's ongoing commitment to force health protection through health risk assessment and finding practical scientific solutions to military operational problems.

BRAC Pictures
(Story on page 1)

Left: Vertical Linear Accelerator (VLA) Center & Right: Disorientation Research Device's (DRD) planetary tower assembly



Breakthroughs in Understanding Aviation Visual Illusions

By Dr. Fred Patterson

Nighttime aircraft accident reports frequently reference the "black-hole" visual phenomenon as a primary causal factor. This visual spatial problem is a form of disorientation that occurs when an aircraft landing approach is made at night, with relatively few visual cues, and often results in the aircraft landing short of the runway. The long held human factors theory regarding the black hole illusion cites a lack of sufficient visual cues as the cause of this disorientation. However, NAMRU-D has found that, rather than simply a lack of visual reference points, it is the adoption of inappropriate spatial strategies causing pilots to fall short of the runway. NAMRU-D researchers can now explain how spatial cues, sensory-spatial reflexes, and the employment of certain spatial strategies make pilots more susceptible to the black hole illusion.

An example of how the new spatial strategies concept works for pilots during flight is illustrated. During clear weather daylight conditions, pilots typically look out the windscreen and perceive the horizon as stationary and the cockpit and surrounding airframe as being in motion relative to that fixed point. As an aviator flies the aircraft, information concerning the distance between the horizon and the cockpit and airframe structures seen in the periphery are continuously and subconsciously evaluated to provide feedback concerning the aircraft's attitude. When the aviator prepares to land, the runway becomes a third spatial reference, which the pilot orients in relation to the horizon and the windscreen, and the landing can be made without incident (figure 1). On a dark night, however, with no visible horizon present, NAMRU-D scientists found that pilots frequently attempt to employ their daytime spatial strategy by substituting the runway for the horizon as their fixed, primary spatial cue. Normally, when a plane approaches the runway, the pilot attempts to keep the horizon centered on the windscreen. However, in a nighttime scenario, the pilot will tend to push the nose of the aircraft down in an attempt to center the runway (the perceived horizon) on the windscreen. As a result, the aircraft takes a shallow approach that, if not corrected for, will cause the aircraft to land short of the runway (figure 2). The response is thought to be reflexive in nature and is contrary to the conventional belief that the illusion is simply caused by insufficient visual cues.

NAMRU-D researchers conducted simulator studies evaluating dark night landing approaches and were able to validate the theory of spatial cues and pilot orientation as a leading cause of black-hole disorientation and not simply the loss of contextual visual reference points. The knowledge obtained in this research was transferred to the Naval Survival Training Institute (NSTI) in the form of training modules designed to enhance pilot awareness regarding the concept of spatial strategies, for the black hole illusion, as well as other illusions that contribute to disorientation during flight. NAMRU-D researchers are poised to pursue future research aimed at cockpit design solutions to help resolve this common and dangerous threat to aviation safety.

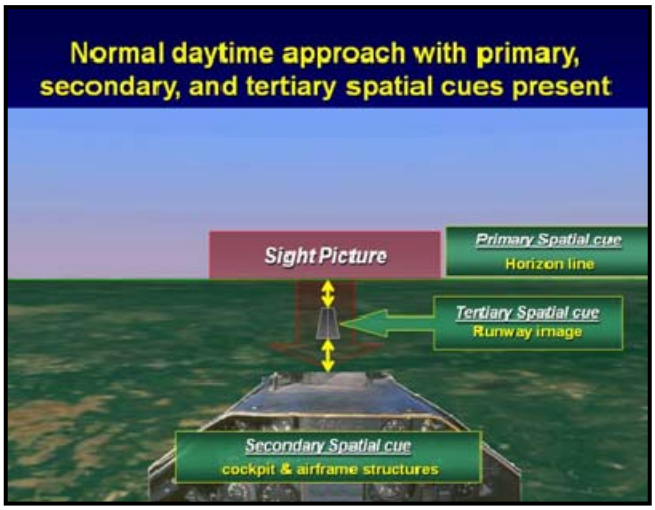


Figure 1: Daytime landing spatial strategy

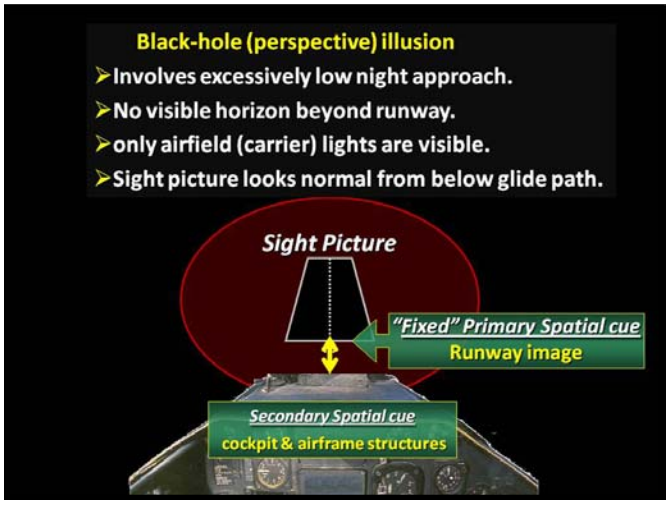


Figure 2: Nighttime landing (no horizon) spatial strategy

NAMRU-D Participates at the Society of Toxicology 50th Annual Meeting

By LT Pedro A. Ortiz

The Society of Toxicology (SOT) 50th Annual Meeting was held 6-10 March 2011 in Washington, D.C. T he annual meeting is the largest toxicology gathering and exhibition in the world, and was attended by more than 7,500 scientists from academia, government, and industry from various countries around the globe. This year's meeting focused on the following scientific themes: Emerging Global Public Health Issues; Environment and Disease; Global Air Quality and Human Health; Integration of Toxicological and Epidemiological Evidence to Understand Human Risk; Novel Approaches to Preclinical Safety Assessment: Bridging the Gap between Discovery and the Clinic through Translational Toxicology; and Toxicity Testing: State of Science and Strategies to Improve Public Health.

NAMRU-D Environmental Health Effects Directorate members in front of the NAMRU-D exhibit booth at the Society of Toxicology Annual Meeting. From left to right: LT Pedro A. Ortiz, Dr. Karen L. Mumy, Dr. Andrew R. Osterburg, Dr. Michael L. Gargas, Dr. Brian A. Wong, and Dr. Lisa M. Sweeney

NAMRU-D's Environmental Health Effects Directorate actively participated in the meeting where attendees had an opportunity to learn about emerging fields and relevant toxicological issues from the wide range of scientific lectures and posters. At SOT, NAMRU-D had an exhibit booth which oriented meeting attendees to some of its current research and capabilities, encouraged interaction with collaborators and sponsors, and promoted scientific discussion. Dr. Karen Mumy presented research focusing on developing a series of cell-based screening methods to rapidly assess military fuels. This work, entitled "*In Vitro* Exposure and Evaluation of Military Fuels and Biofuels," was presented in the Mechanistic Assessment of Chemical Mixtures session and highlighted two biofuels currently undergoing testing. Hydro-treated renewable jet fuel made from camelina and biodiesel F-76 generated from algae were evaluated for their cytotoxic and mutagenic potential. It was determined that both biofuels were less cytotoxic than their conventional fuel counterparts (JP-5 and F-76) and neither displayed evidence of mutagenicity. This work was featured in the first NAMRU-D Science Update. Overall, the meeting served as an excellent venue for NAMRU-D to share current research and future directions aimed at enhancing the protection and performance of military personnel.

NAMRU-D Presentations & Products

Adams, V., Bannon, D., Stockelman, M., & Mokashi, V. (2011, March). *The effect of tungsten alloy surrogates on PC12 cell gene expression*. Poster presented at 1st annual Armed Forces Public Health Conference, Hampton, VA.

Mumy, K., Doyle, T., & Okolica, M. (2011, March). *Rapid evaluation of military fuels and biofuels*. Poster presented at 1st annual Armed Forces Public Health Conference, Hampton, VA.

Mumy, K., Doyle, T., Okolica, M., Adkins, R., & Eldridge, G. (2011, March). *In vitro exposure and evaluation of military fuels and biofuels*. Poster presented at 49th Annual Meeting of the Society of Toxicology, Salt Lake City, UT.

Ortiz, P. A., Fechter, L. D., Fisher, J. W., Mokashi, V., Reboulet, J., Stubbs, J., Prues, S., McInturf, S., Gearhart, C., Fulton, S., & Mattie, D. (2011, March). *Evaluation of jet fuel induced hearing loss.* Poster presented at 1st annual Armed Forces Public Health Conference, Hampton, VA.

Wong, B., Gargas, M. L., & Hussain, S. (2011, March). *Toxicity evaluation of nanomaterials via inhalation exposures.* Presentation at 1st annual Armed Forces Public Health Conference, Hampton, VA.

Wong, B., Roberts, K., Parkinson, C., Mokashi, V., & Ortiz, P. (2011, March). *Toxicity of particulate matter from Afghanistan and Iraq in a two-week inhalation study in rats*. Poster presented at 49th Annual Meeting of the Society of Toxicology, Salt Lake City, UT.

Researchers at NAMRU-Dayton and UDRI to Study Neural Mechanisms of Spatial Orientation

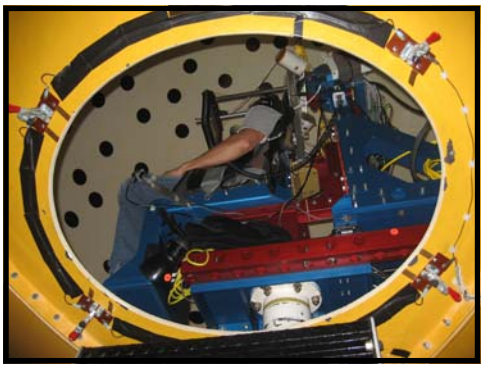
By LCDR Philip G. Fatolitis

Spatial disorientation remains the most common cause of Class A aviation mishaps in the naval services and across the Department of Defense. In the search for solutions to this continuing threat, Naval Medical Research Unit- Dayton (NAMRU-D) researchers are pursuing a range of basic and applied research initiatives. An understanding of fundamental principles governing how spatial orientation is established - and how it is lost – is critical to this endeavor. One new NAMRU-Dayton project is using advanced EEG (electroencephalography) technology to classify neural activity during spatial orientation tasks. Recent animal research has identified several classes of highly specialized neurons involved in spatial orientation. These specialized neurons – grid cells, boundary cells, and head direction cells – are located in the entorhinal cortex and hippocampus, and are linked to other specific brain regions important to spatial processing. These specialized cells have been found to work together to create an "anatomical spatial display" which operates much like a compass orienting an organism to its location within an environment.

Human research presents a challenge, however, since it is not possible to perform single neuron microelectrode recordings, as has been done in the animal research. However, an advanced EEG technology, high-density array EEG, provides high resolution neuroelectrical signal data allowing researchers to localize activity to specific brain regions during task performance. In this project, NAMRU-D researchers are teaming with researchers at the University of Dayton Research Institute (UDRI) in an attempt to localize human neural activity while performing spatial orientation tasks. The only previous human research in this area has utilized functional magnetic resonance imaging (fMRI). While it is an effective tool for neuroimaging, fMRI does not allow for participant motion. High-density array EEG, however, allows for limited participant motion. This study will introduce both participant motion and visual stimulus motion, using NAMRU-Dayton's Visual Vestibular Sphere Device with a goal of distinguishing between somatic and visual influences on spatial orientation. It is hoped that this basic research will identify tools and techniques for future applied NAMRU-D research in spatial orientation.

Above: EGI High Density Array EEG system in UDRI's Human Factors Group Lab

Below: NAMRU-D's Visual Vestibular Sphere Device (VVSD) will be used to produce spatial orientation stimuli.

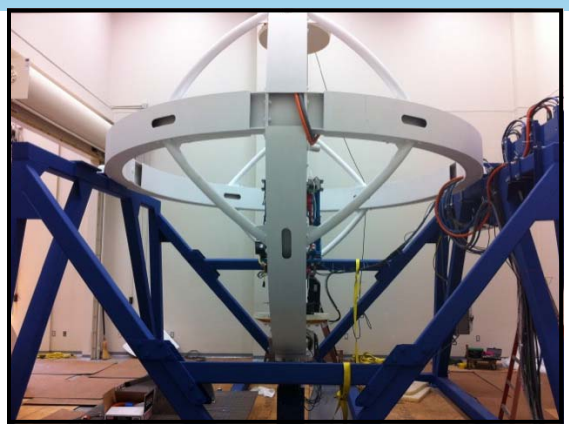


BRAC Pictures

(Story on page 1)

Left: Equipment and machines placed in the Fabrication Shop

Right: The structure of the Visual Vestibular Sphere Device (VVSD) during assembly



NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY

NAMRL

NAMRL MISSION: To conduct research, development, test, and evaluation in aerospace medicine and related sciences to enhance the health, safety and operational readiness of navy, marine corps, and other military personnel.

Officer in Charge, Acting: LCDR Robert Higgins **Pensacola, FL**

Pensacola Data Collection Wraps Up for Two Studies

By Dr. Joseph F. Chandler & Dr. Jeffrey B. Phillips

Researchers in NAMRL's Aviation Hypoxia Performance (AHP) and Continuous Operations Performance Enhancement (COPE) laboratories completed data collection on their final Pensacola-based experiments. The AHP study was designed to document the effects of hypoxia on cognitive perceptual performance and the amount of time required post-hypoxia exposure for performance to return to pre-exposure levels. A total of 25 subjects breathed air mixtures equivalent to 18,000 feet for 30 minutes while performing a battery of cognitive perceptual tasks. Upon return to sea-level air mixtures, subjects' task performance recovery profiles were assessed. Investigators are now executing the analysis phase of the project, with results expected after the transition of the AHP lab to NAMRU-Dayton this spring. Results will be presented at the 2011 meeting of Aerospace Medical Association to be held in Anchorage, Alaska in May.

Researchers from the COPE lab have begun analysis of flight student cognitive and physiologic performance under realistic fatigue conditions. While the majority of laboratory fatigue researchers study acute sleep deprivation, the true threat of sustained operations is chronic, partial sleep restriction – reduced nightly sleep over extended periods of time. To reflect this, the COPE lab limited subjects to 4 hours of sleep per night for 4 nights. Subjects then completed a suite of tests every three hours while awake over the course of 4 days. Fatigued performance is being compared to rested baseline scores taken the week before sleep restriction using individualized analysis. Results will inform fatigue modeling and mitigation with data that more closely simulate operational conditions. Together, these studies exemplify the seamless continuation of scientific activities occurring as Naval aeromedical research transitions from Pensacola to Dayton.

NAMRL staff observe subject performance in Fatigue study

NAMRL Publications & Products

Arnold, R. D., & Guest, M. (2011). Identification of multi-UAS operator and crew skill and ability requirements [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 239-240.

Chandler, J. F., Simmons, R. G., & Schmitz, T. M. (2011). Pharmacological countermeasures for motion sickness: State of the science in the 21st century [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 170.

Dory, R. E., Simmons, R. G., Horning, D. S., Phillips, J. B., & Chandler, J. F. (2011). Response characteristics of oxyhemoglobin saturation sensors during rapid onset altitude exposure: Potential for in-cockpit hypoxia monitoring [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 327.

Fatolitis, P. (2011, Spring). Spatial disorientation research and the continued effort to make flying safer. *U.S. Naval Aerospace Experimental Psychologist's Society's newsletter "Call Signs" 2*(1), 10-11.

Gao, H., Taylor, M. K., & Horning, D. S. (2011). Pupillometry as an investigative tool in the aeromedical sciences: Mechanistic pathways and methodological considerations [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 244.

Phillips, J. B., Simmons, R. G., Horning, D. S., & Kotch, R. A. (2011). Effects of moderate normobaric hypoxia on cognitive function [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 176.

Simmons, R. G., Chandler, J. F., & Taylor, D. L. (2011). Recent developments in the theoretical mechanisms of action of scopolamine: A systematic review [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 297.

Taylor, M. K. (2011). Relationships between resilience and health status in military personnel, Part II: Extension of previous report [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 294-295.

Taylor, M. K. (2011). The neuroactive steroids dehydroepiandrosterone and dehydroepiandrosterone sulfate: Anabolic, neuroprotective and neuroexcitatory effects [Abstract]. *Aviation, Space, and Environmental Medicine, 82*(3), 373-374.

Taylor, M. K., Horning, D. S., Chandler, J. F., Phillips, J. B., Khosravi, J. Y., Bennett, J. E., Halbert, H., Fern, B. J., & Gao, H. (2011). *A comparison of approaches to detect deception* (Report No. ADA537848). Retrieved from http://handle.dtic.mil/100.2/ADA537848

Commanding Officer's Corner

By Keith Syring

Captain Keith Syring, USN
Commanding Officer

The arrival of spring in Southwest Ohio has ushered in, not only a flurry of research activity, but several unique challenges. The first challenge has been uncertainty regarding the current budget year. This issue has posed limitations for all the NMR&D labs, but I am pleased to report that the NAMRU-Dayton research staff has been able to grow research funding two-fold during the course of this fiscal year. Another large challenge has been BRAC execution. During the month of March, we took control of our new headquarters and aeromedical research building on Wright-Patterson AFB, accepted delivery and installation of the Visual Vestibular Sphere Device (VVSD) and the Vertical Linear Accelerator (VLA) research devices, and watched as six tractor-trailers arrived from Pensacola to start filling in our new aeromedical research spaces with a variety of one-of-a-kind research equipment. The building and lab spaces are phenomenal. With all new facilities and the addition of several new research capabilities, we fully expect NAMRU-Dayton to be "the destination" for aeromedical research. While too numerous to list everyone by name, I would like to take a moment and thank everyone who helped bring this building on line. There is still much to accomplish before we can call BRAC complete - but the end is in sight.

We continue to work on expanding the capabilities and research activities of both the Environmental Health Effects and Aeromedical Research Directorates. We are excited to showcase this wonderful new command, and deliver research products to the fleet to enhance the health, safety, and performance of our operational customers. On the personnel side Mr. Roy Dory, the first of the NAMRL personnel who are transferring, arrived in Dayton. Over the next few months we will be welcoming more of the civilian personnel moving up to the area. In closing I would like to again applaud the efforts of all of the BRAC personnel; everything to date has been planned and executed flawlessly, and we are on track to complete the transition on time and in spectacular style.

Taking the Helm of Navy Medicine's Aeromedical & Environmental Health Research

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